

Concept of energy production from radioactive contaminated biomass on the territory of Chernobyl exclusion zone

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The Chernobyl Nuclear Power Plant Unit 4 accident, which occurred on April 26, 1986 has led to considerable contamination of nearby territories by radionuclides. The total area of Chernobyl Exclusion Zone (CEZ) is about 2000 km². The forestry areas cover about half of CEZ. At present there are more than 21 mill Cu of radioactivity on the territory CEZ including approximately 20 mill Curies inside object "shelter" (concrete sarcophagi above destroyed Unit 4), 380 thous. Curies – in the points of temporary localization and burial of radioactive waste, 250 thous. Curies – on the territory (appx. 129 thous. Curies – strontium ⁹⁰Sr, 120 thous. Curies – cesium ¹³⁷Cz, 1000 Curies – transuranium ²³⁹⁻²⁴⁰Pu) [1].

There are three regimes of specialised ecology-forestry handling on the territory of CEZ [1]:

Regime of handling	Density of contamination, Curies/km ²		
Controlled	Cz ¹³⁷ <40	Sr ⁹⁰ <3	Pu ²³⁹ <0.1
Restricted	Cz ¹³⁷ 40-100	Sr ⁹⁰ 3-10	Pu ²³⁹ 0.1-0.3
Guard (reserved)	Cz ¹³⁷ >100	Sr ⁹⁰ >10	Pu ²³⁹ >0.3

The total reserves of wood in these areas are equal to 2630 thous. t, 2260 thous. t, 2790 thous. t, correspondingly. The radionuclides distributed on the forestry territory are located mainly in the upper layer of forest substrate (soil) of appx. 10 cm thickness (more than 94%), and also in the needles and leaves (more than 3%). The timber wood are relatively clean from radionuclides.

In 1996 the power consumption of CEZ was 35 mill kW·h (equivalent of 4 MW_e installed capacity) and heat consumption - 160 thous. Gcal (equivalent of 87 MW_{th} installed capacity). The existing boiler houses are distributed in CEZ as follows: Chernobyl – 46 MW_{th}, Leliov – 15.5 MW_{th}, Dibrova – 5.2 MW_{th}, Opachichi – 0.7 MW_{th}, Buriakovka – 0.8 MW_{th}, Zalesie – 0.7 MW_{th} (the total installed thermal capacity is about 70 MW_{th}). The other part of heat consumption was covered by Unit 3 of Chernobyl Nuclear Power Plant up to December 2000, when it was stopped.

The Concept of Energy Production from Radioactive Contaminated Biomass on the Territory of CEZ.

1. To cover present and future heat and power consumption on the territory of CEZ fully on the base of wood fuel combustion.
2. To implement the CHP plant near Chernobyl (most likely in Leliov) of 30 MW_e + 60 MW_{th} capacity. During the heating season the plant will work on the base of combined cycle with covering of Chernobyl and Leliov heat consumption and during the other time – on the base of condense cycle only with power generation.
3. To implement wood-fired boilers with moving grates on the places of existing boiler houses using when it is possible existing boiler houses and heating nets: Dibrova - 5 MW_{th}, Buriakovka - 4.5 MW_{th}.
4. To use commercially available bag-house or electrostatic filters installed after wood-fired boilers for flue gas cleaning from fly ash containing radionuclides.

The Concept of Felling, Treatment and Transportation of Radioactive Contaminated Wood Fuel on the Territory of CEZ.

It is developed the concept of felling, treatment and transportation of radioactive contaminated wood fuel based on the some main points:

Clear-cutting.

It is proposed to use the clear-cutting method of felling for production of fuel wood on the territory of CEZ. It leads to following advantages in comparison with thinning:

- ?? Clear-cutting allows to organise fully mechanised tree felling and wood chips production with considerable reduction of total dose of radioactive irradiation for personnel. The application of harvesters and chippers with pressurised cabins and filters for inlet air practically excludes internal radioactive irradiation through breathing ways.
- ?? Clear-cutting leads to minimal cost of wood chips production.
- ?? Clear-cutting with wood chips production from timber wood allows to remove about 3% of radionuclides distributed on the territory of CEZ, and under whole tree wood chips production (including twigs and needles) – about 6%. It's a "direct" contribution to cleaning of CEZ territory from radionuclides.
- ?? The new forest which will grow on the clear-cut territories of CEZ practically will not contain transuranium radionuclides and will contain considerably less amount of ^{137}Cs and ^{90}Sr , than existing forest. Under this scenario the new forest may be used as commercial product in 50-80 years.
- ?? Clear-cutting according to certain schema (for example like shelterbelts) may considerably improve the fire-protection situation of forests in CEZ.
- ?? Clear-cutting may lead to some raise of underground water level due to decreasing of water evaporation through the trees. It leads to increase of moisture content of soil and to acceleration of radionuclides migration deep into the soil. Under penetration of the main part of radionuclides on the deepness of 20 cm the total dose of irradiation above the ground decreases appx. in 5 times. It's "indirect" contribution to cleaning of CEZ territory from radionuclides.

Transportation of fuel wood as wood chips but not as logs.

The cost of fuel wood under its transportation in the form of wood chips almost twice cheaper than under its transportation in the form of logs. For the most contaminated areas it is proposed to produce wood chips directly on the place of felling and to transport it directly to the CHP plant or boilers. For other territories it is possible to produce wood chips near the road after approximately half-year drying period of cut trees in the forest.

Rational use of seasons.

The minimal moisture content of trees is in winter period. Besides, during this period (under snow covering of ground) there is minimal aspiration of radionuclides from the ground to air under felling and wood chips production procedures. Then it is strongly recommended to carry out felling and transport up to the road operations during winter period. Wood chips may be produced near the road in other seasons after drying period and according to requirements of CHP plant/boilers in wood chips.

New afforestation of the clear-cut areas.

It is proposed the new afforestation of clear-cut areas, first of all by using of existing young trees. Then approximately in 30 years after clear-cutting the underground water level will return to before cutting conditions and situation with accelerated migration of radionuclides with underground water will return to present state.

Acknowledgement.

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References

1. A. Arkhipov, N.Kuchma. Radioecological Feasibility of the Project. Proceedings of the Chornobyl Phytoremediation and Biomass Energy Conversion Workshop. Slavutych, Ukraine, February 23-25, 1998, p. 79-105.